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Sources of annual to decadal predictability

Jeff Knight

OCP Workshop, Barcelona, Thursday 31st May 2018

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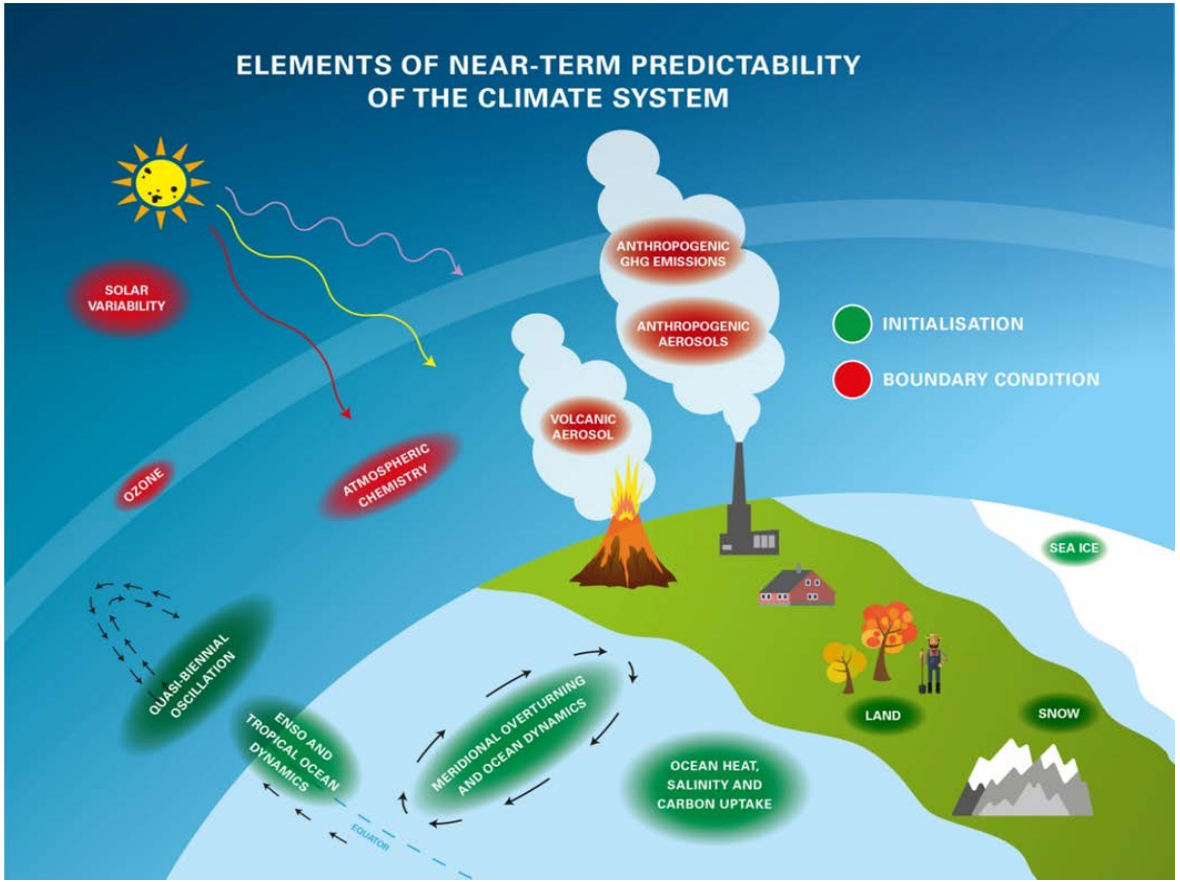

Kushnir et al, submitted

Recent decadal variability/trends

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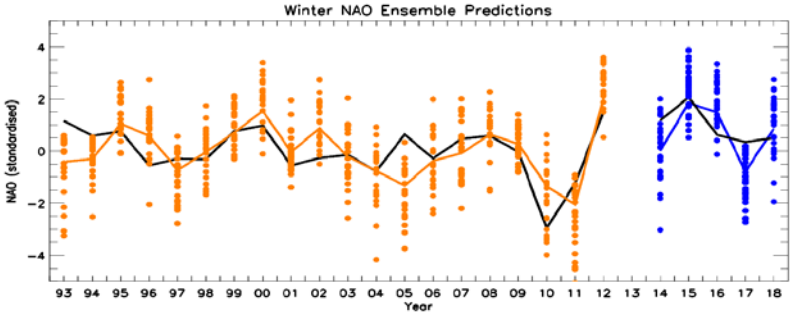
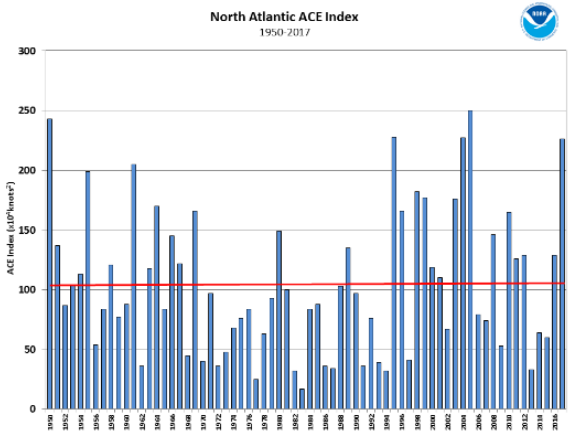
Latest variability in the NAO



After Scaife et al 2014

Future increase or decline?

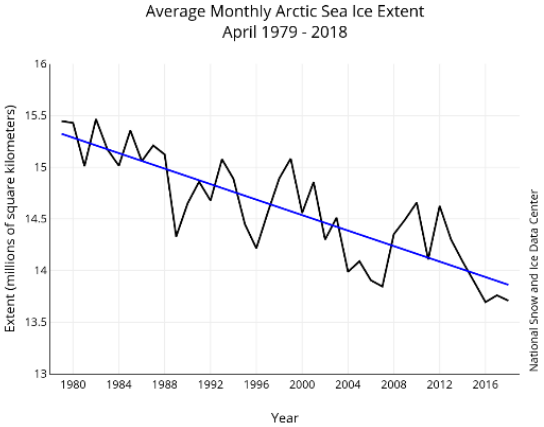
Latest variability in tropical storm activity



Recent downturn
Last year was very active

NOAA

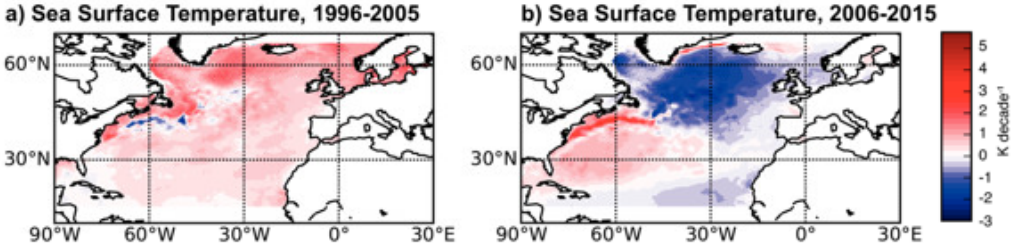
Latest Variability in Arctic Sea Ice



Does this matter for remote climate?

NSIDC

Latest variability in the AMO



Recent downturn in N Atlantic SST
Relationship with NAO?
Influence on overlying atmosphere?

Robson et al 2016

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Sources of Predictability: Forcing

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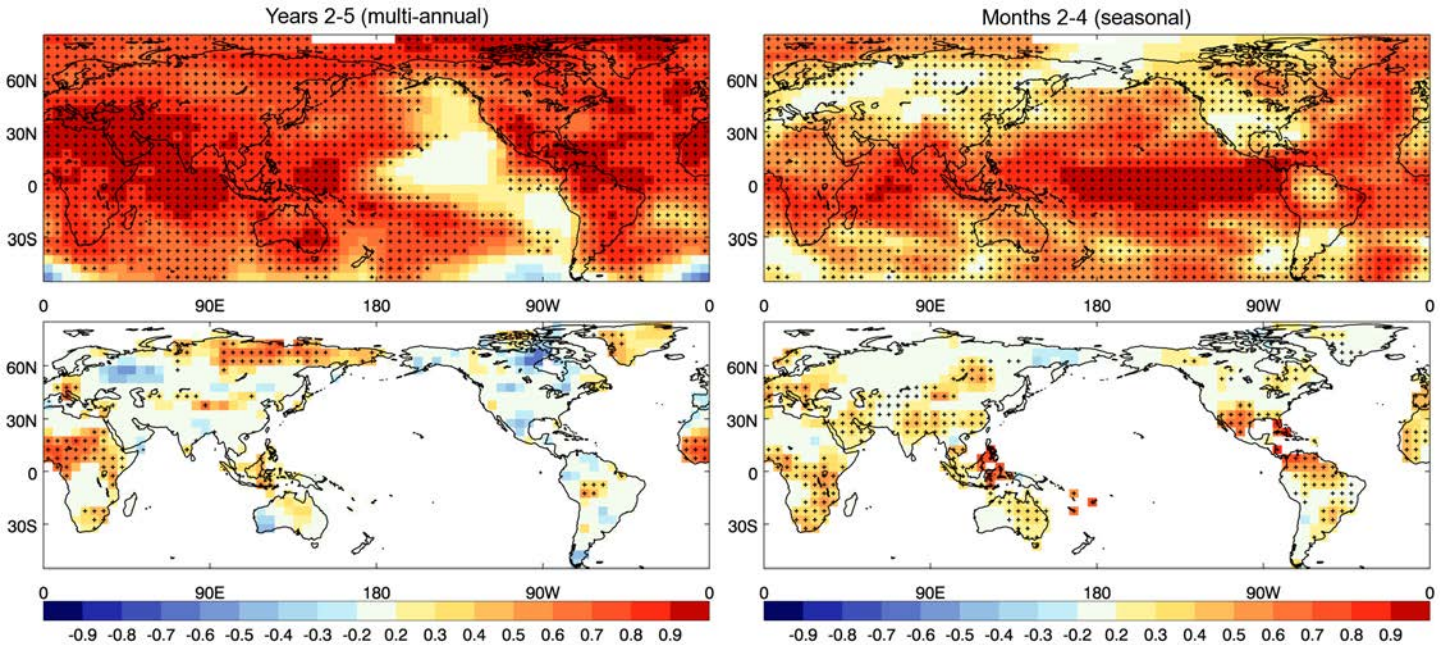
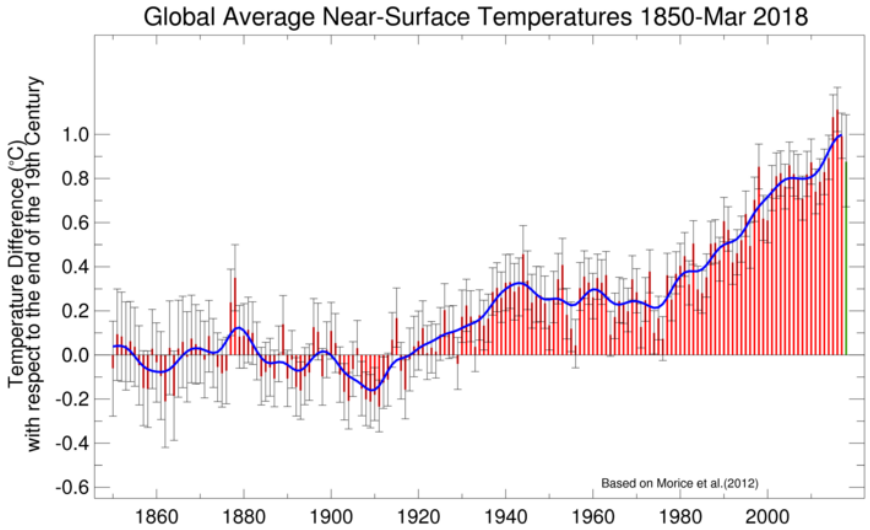
Decadal predictions are more skilful than seasonal predictions



And anthropogenic change is large enough to contribute to decadal prediction skill

Kushnir et al, submitted

Anthropogenic warming on timescales of less than a decade



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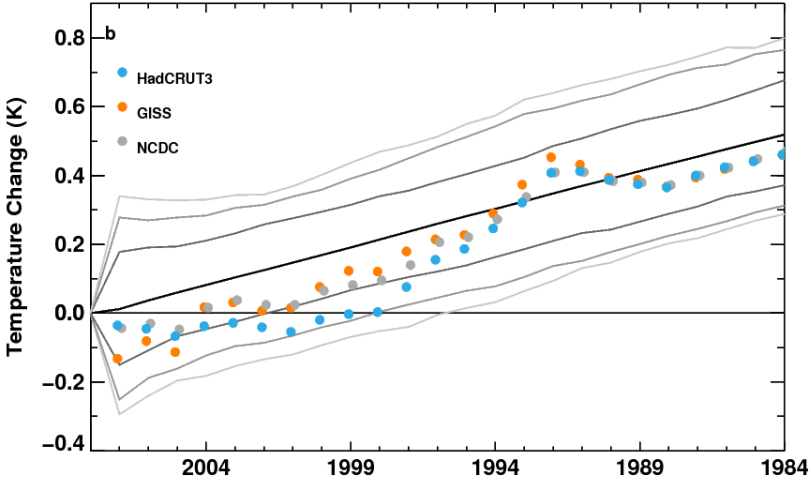

Knight et al 2009

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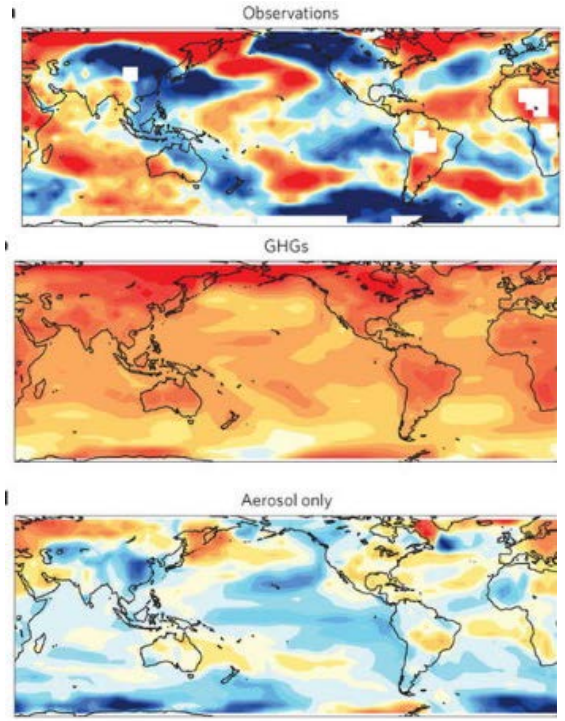
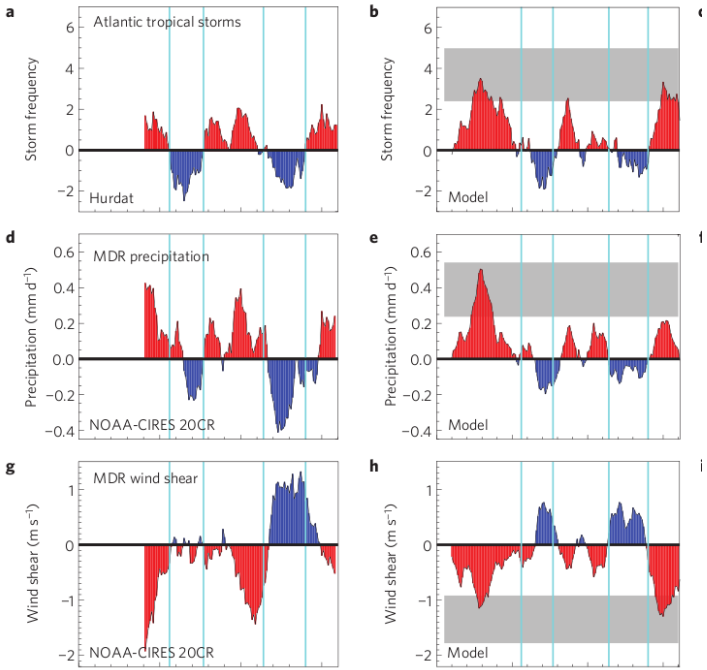
Are aerosols important?

Recent variations in aerosol Forcing



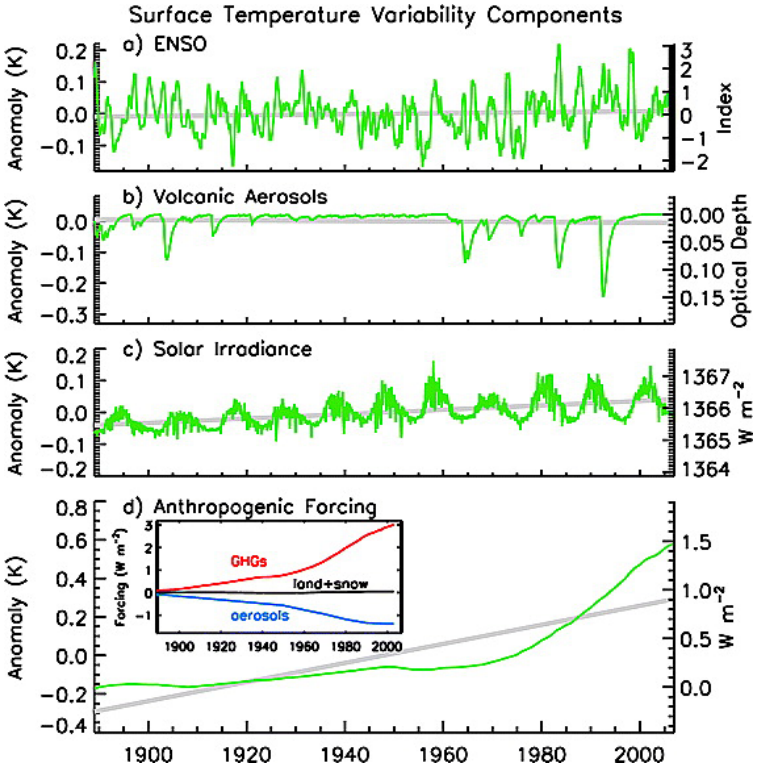
Smith et al, 2016

Total aerosol forcing can drive hurricanes

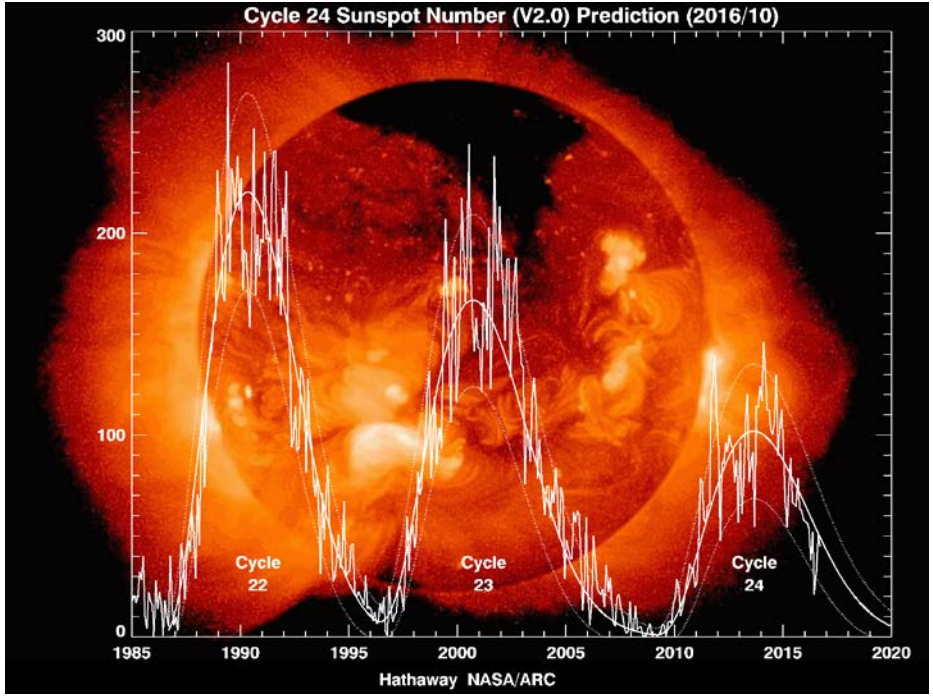


Dunstone et al, 2013

Solar Variability



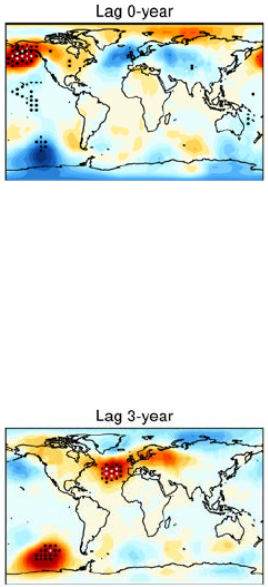
Lean et al 2008



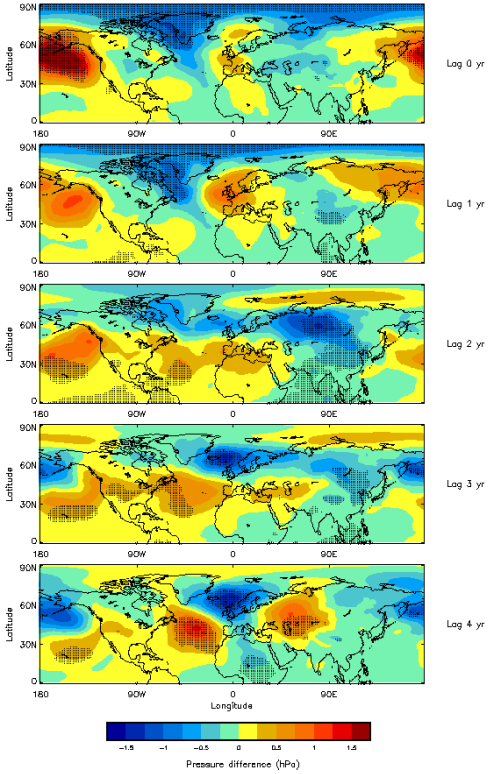
Solar variability is heading for a (deep?) minimum

Solar Variability and the NAO

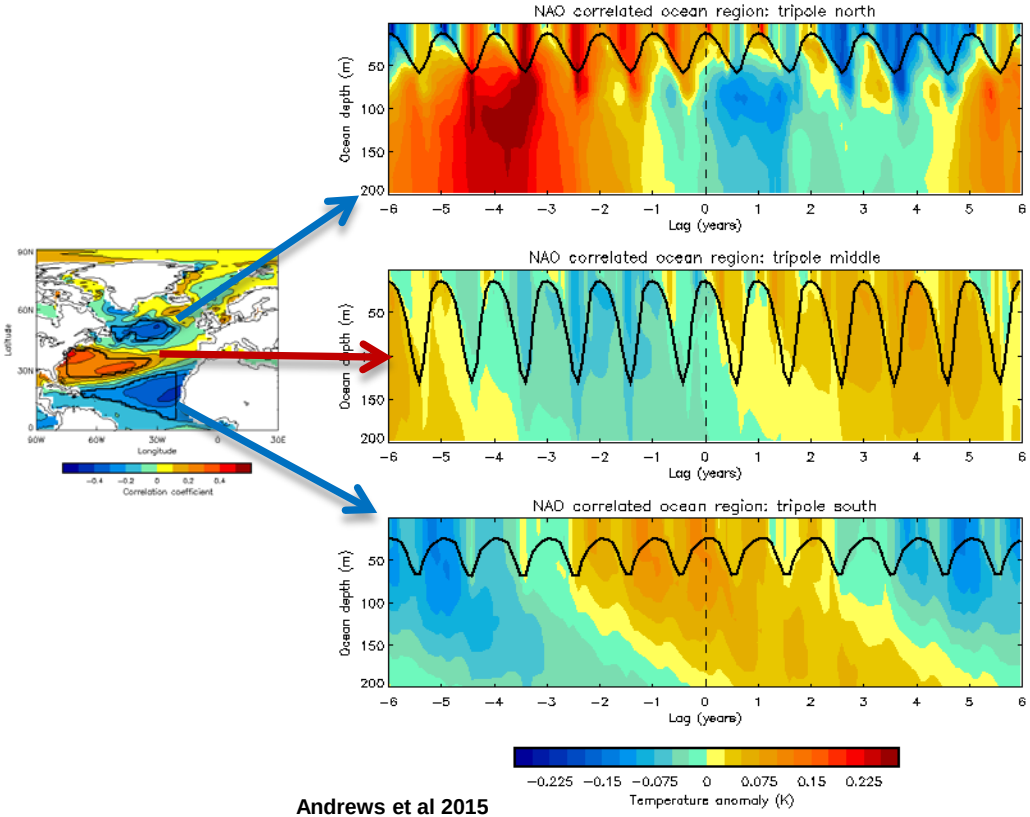
Solar variability is related to the winter NAO



Gray et al 2013



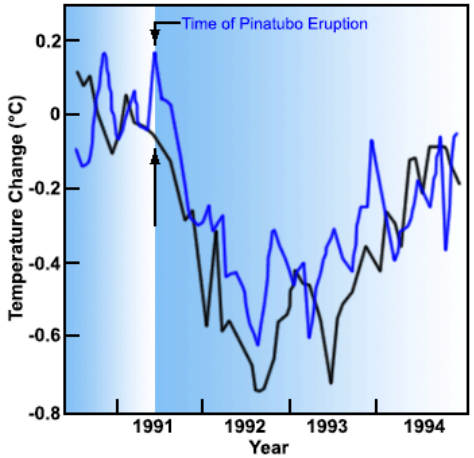
Andrews et al 2015



Andrews et al 2015

Volcanic Eruptions

Big global effect of explosive tropical eruptions

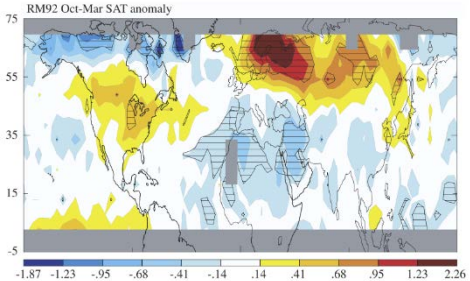


After Hansen 1992

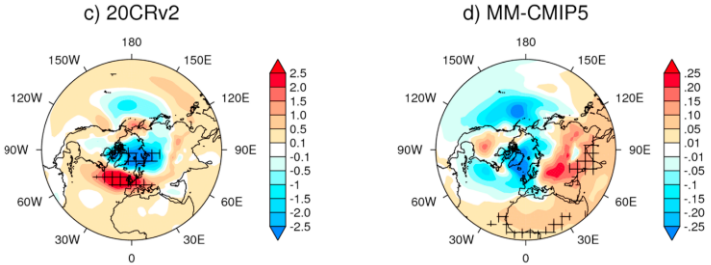
In 2017, looked possible Mt Agung could erupt

Are we ready for these relatively rare events? What advice would we give after an eruption? What would this be based on?

NAO impact of eruptions



Shindell et al, 2004



Driscoll et al 2013

Other impacts, ENSO?

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Sources of Predictability: Variability

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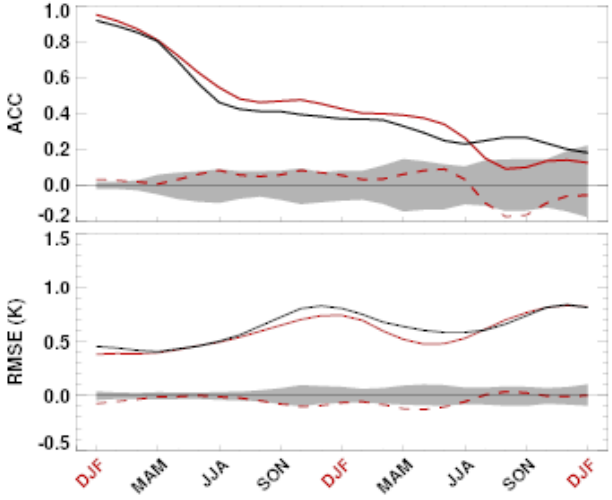
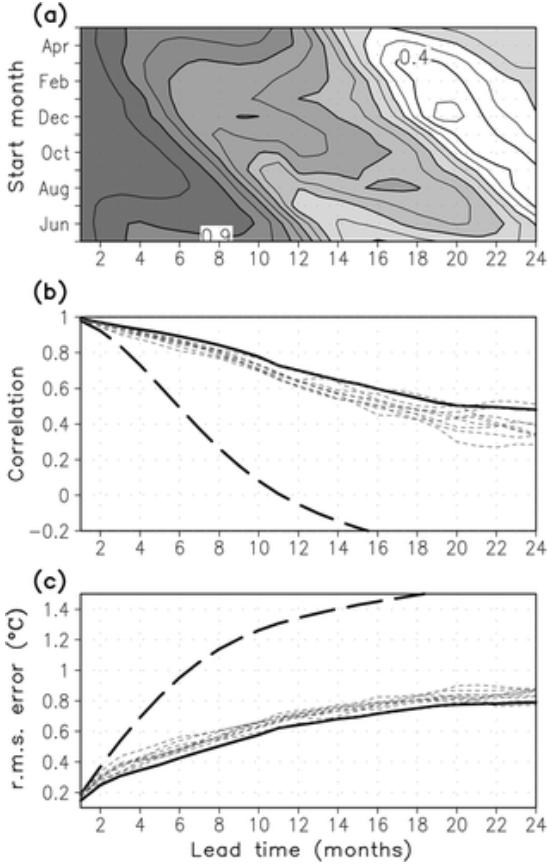
ENSO prediction beyond 1 year

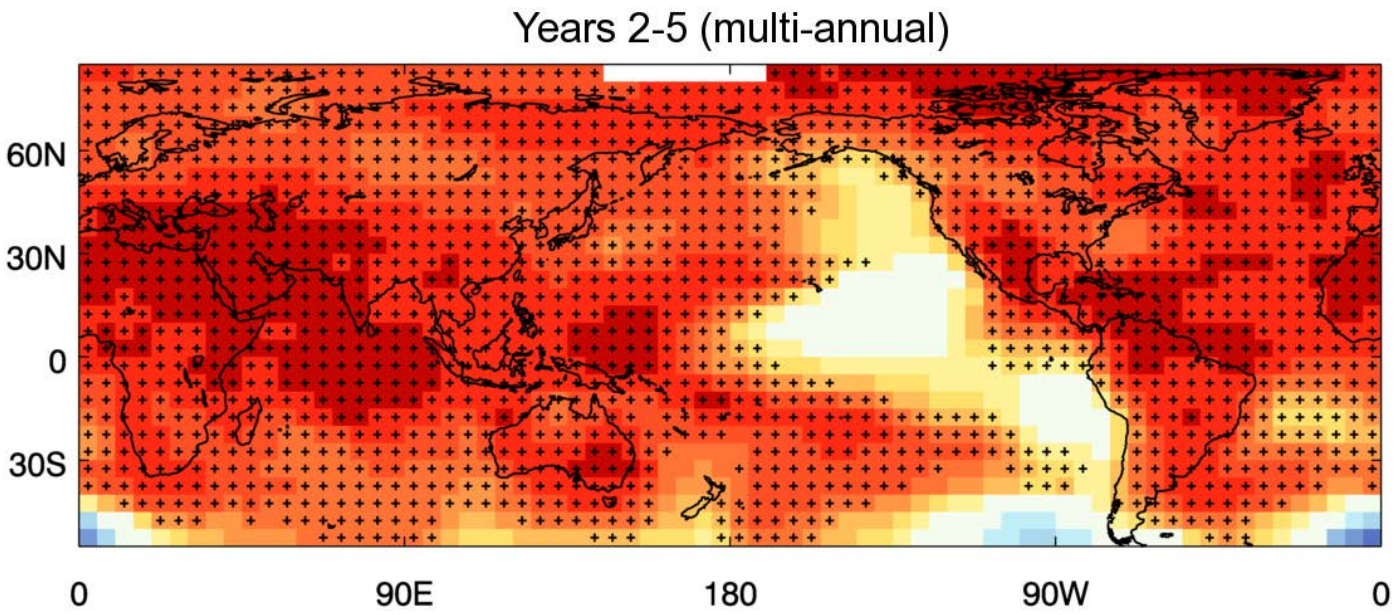


Knight et al 2014



Luo et al 2008

Pacific Decadal Variability



PDO/IPO is often considered to be stochastically driven
Role of forcings?

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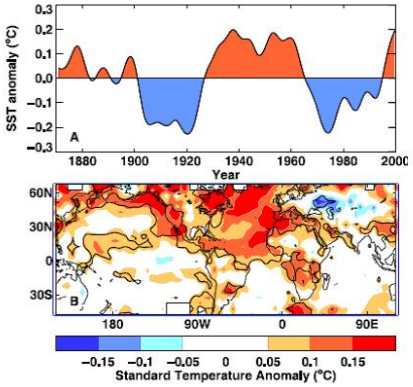
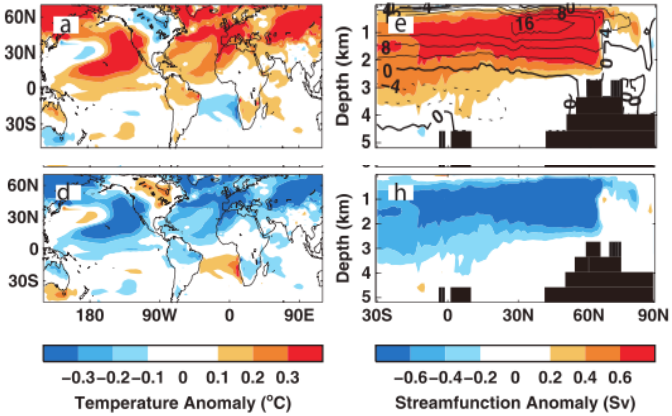
Atlantic Variability

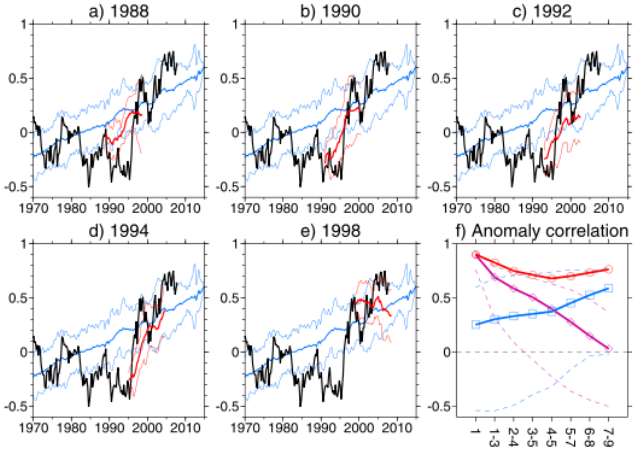
The AMV is related to the AMOC

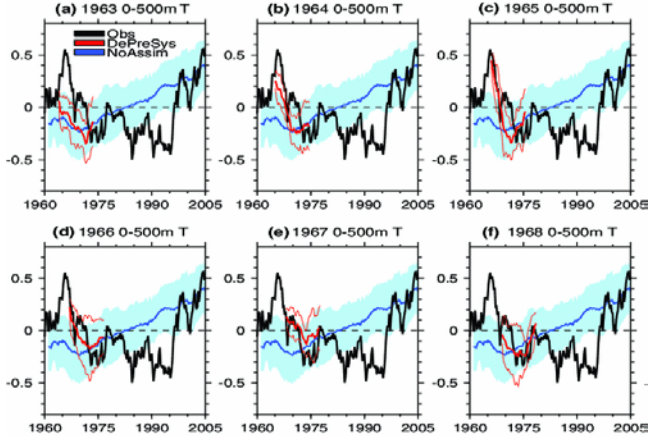




Knight et al 2005

Annual to decadal prediction for SPG



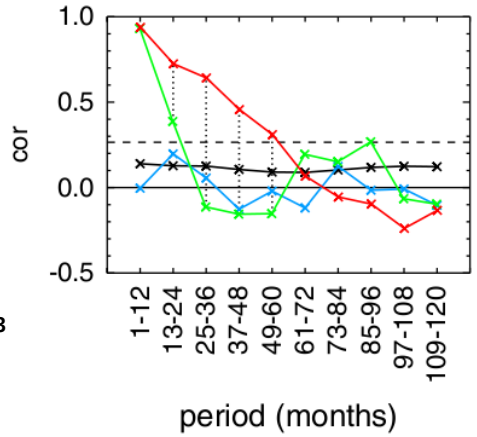


Robson et al 2012

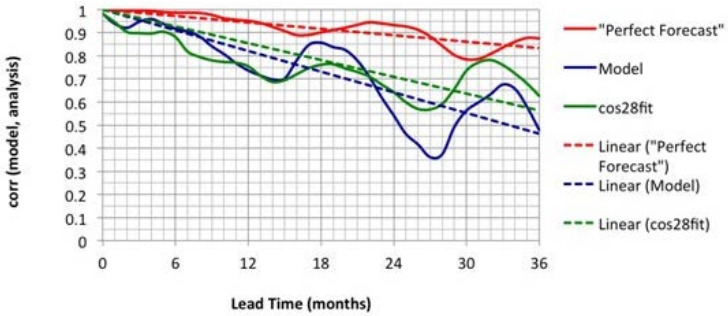
Robson et al. 2014

Quasi-Biennial Oscillation

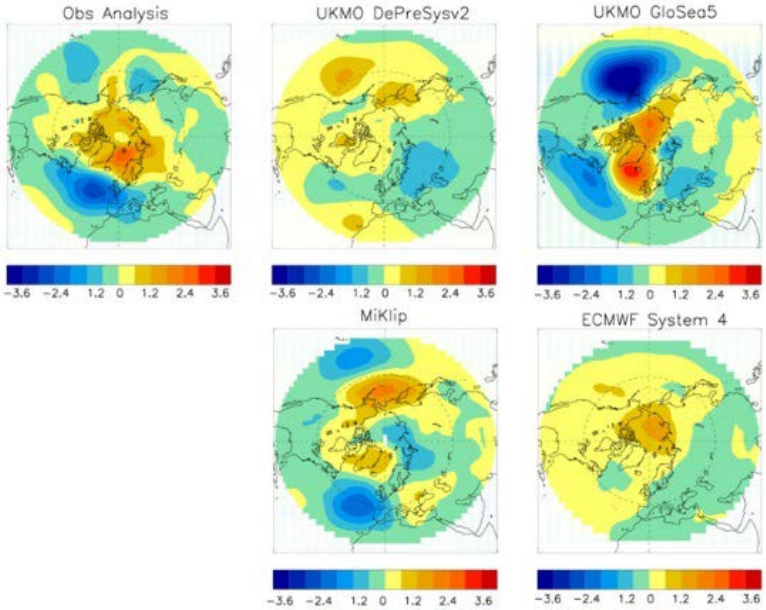
The QBO is predictable out to years ahead



Pohlman et al, 2013



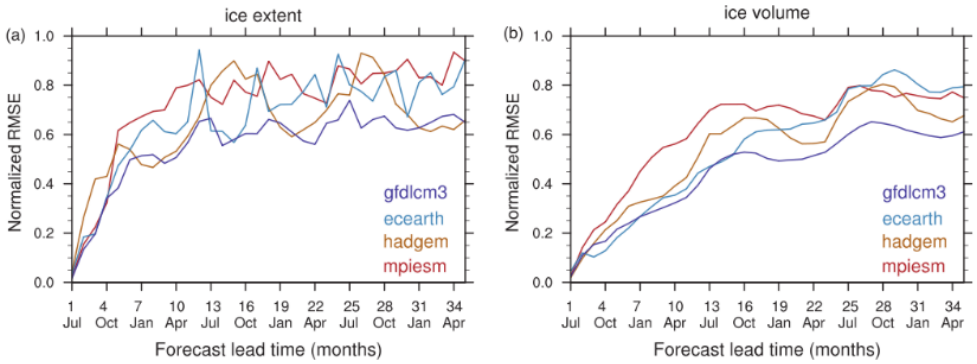
But surface teleconnection is not well reproduced



Scaife et al, 2014

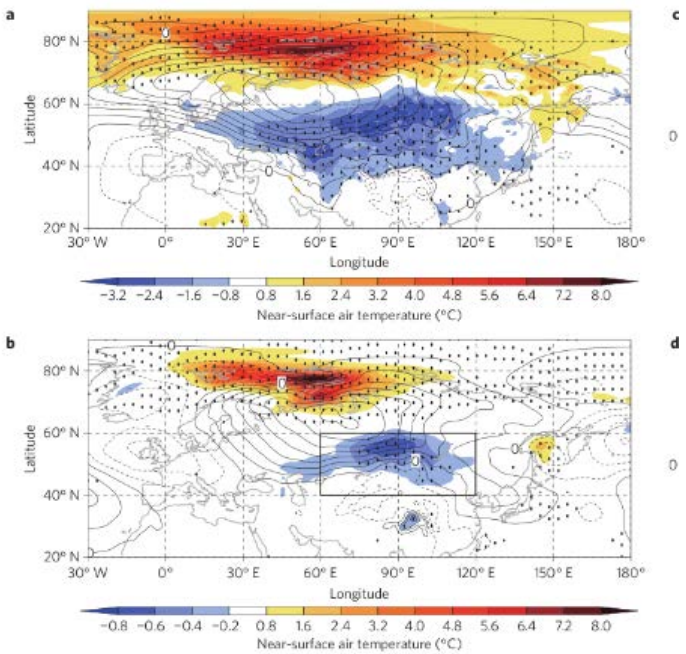
Is sea ice important?

Sea ice is predictable months perhaps a few years ahead



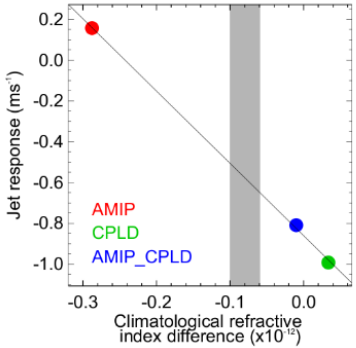
Guemas et al, 2016

Some studies suggest lower latitude responses



Mori et al, 2016

But surface teleconnections are uncertain



Smith et al, 2016

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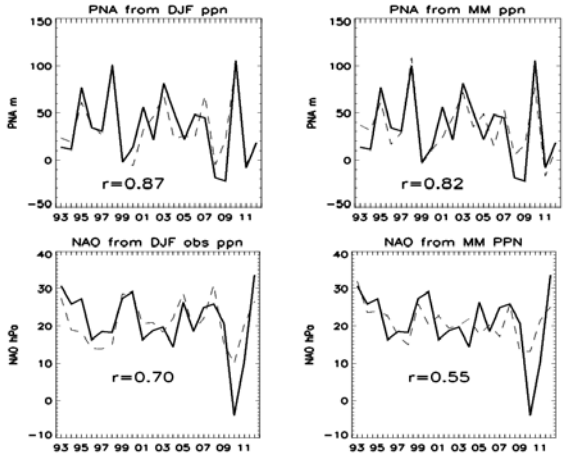
Conclusions

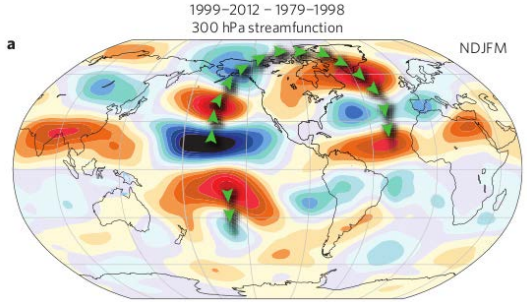
- The climate system on annual to decadal timescales is highly multi-faceted, with out a singe controlling factor
- Prediction skill on these timescales has the following sources:
  - External Forcings: greenhouse gases, aerosols, solar, volcanic, ozone
  - Climate variability: ENSO, AMV, AMOC, PDV/IPO, QBO, sea ice …
  - Initial ocean conditions: Doug Smith will discuss
- Single influences can have different impacts in different locations, e.g. volcanic eruptions give tropical cooling but can lead to high-latitude winter warming
- This complexity is a challenge … but also an opportunity

Is tropical rainfall important?

Tropical rainfall is important for interannual variability



Tropical decadal variability affects the extratropics



Trenberth et al, 2014

Scaife et al, submitted